Shapes-from-silhouettes based 3D reconstruction for athlete evaluation during exercising

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Abstract

Shape-from-silhouettes is a very powerful tool to create a 3D reconstruction of an object using a limited number of cameras which are all facing an overlapping area. Synchronously captured video frames add the possibility of 3D reconstruction on a frame-by-frame-basis making it possible to watch movements in 3D. This 3D model can be viewed from any direction and therefore adds a lot of information for both athletes and coaches.

1 Introduction

Currently during training and competition video is used to improve technical aspects in sports. However, since video is a 2D projection of 3D movements, some information is lost, especially because joint angles can only be measured accurately when the angle lies perfectly in the plain parallel to the image sensor. For simple movements in front of a fixed camera this does not form a real limitation, but for movement where joints move freely, the requirement of a parallel plane is seldom met. Our solution is to use multiple fixed and calibrated cameras, facing the same overlapping area in which we are able to reconstruct the moving objects - in this case a person - in 3D. As opposed to other systems, our system does not use markers, which mean it is non-intrusive and leads to a significant gain in terms of time. Another benefit is that the system is still applicable when markers are not allowed, for example during competitions.

2 Our algorithm

The algorithm we use was presented in previous conferences (*1*) (*2*) (*3*). Our algorithm differentiates from traditional shape-from-silhouette algorithm in the sense that is is able to reason with occlusion. Occlusions occurs when there is an object in the scene blocking the view of a camera looking at the object which will be reconstructed. We detect this automatically and make sure that the impact on the final shape is limited. From the 3D model we are capable to extract some basic features like center of mass, positions on the ground, height of a jump ...

3 Results

We evaluate the results by looking at some screenshots of our algorithm (figure 1). What we see is a 3D model which can be paused at any moment and played forward and backwards at any time. This feature enables a 3D view of technical executions for step-by-step analysis. The accuracy for this example is set

to 1cm which proves to be accurate enough for reconstruction of a human. We use the CVSSP3D dataset for testing (*4*). This dataset offers 8 synchronised video streams from multiple movements. Our algorithm is capable of running in real-time with lower accuracy (2-4cm), which in most cases still enables detailed analysis of the human motion.

4 Conclusion

We showed the capabilities of our algorithm for technique analysis during training. We use multiple cameras to obtain a 3D reconstruction based on the shape-from-silhouettes principle. The system is easy to use and shows good performance.

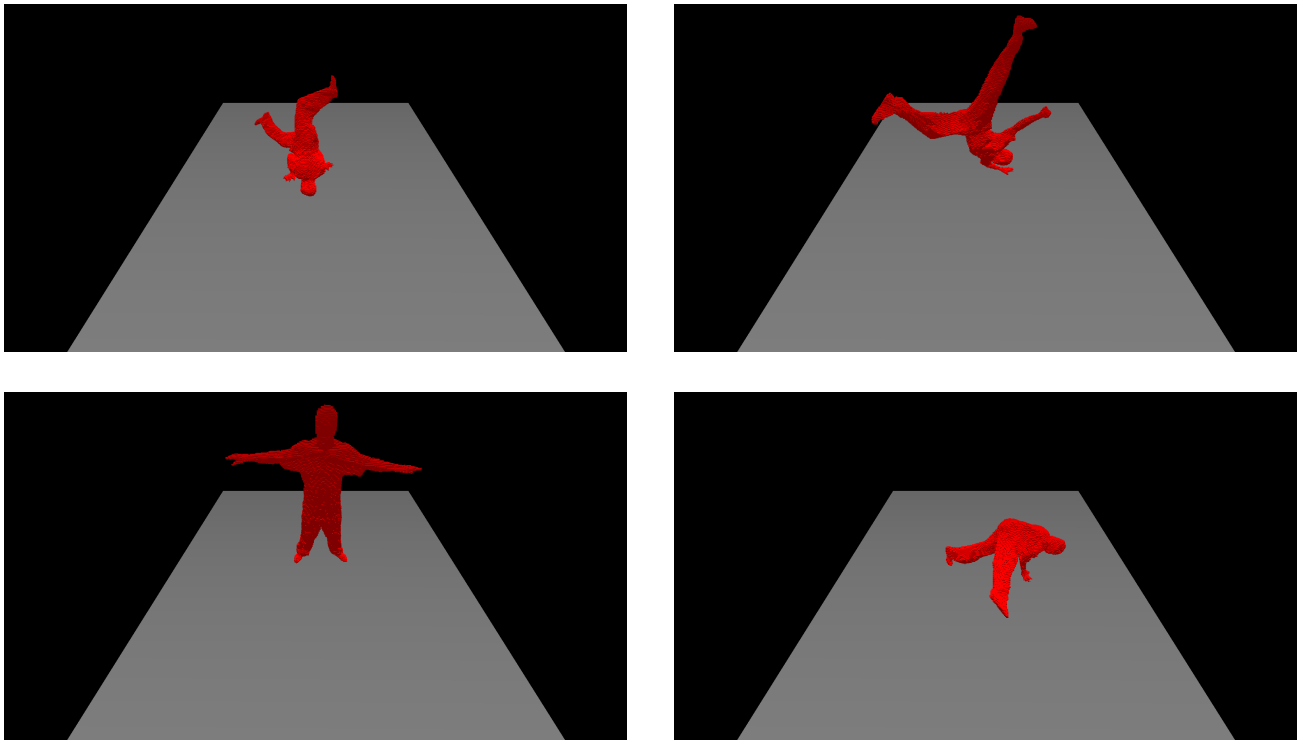

Figure 1: Screenshot of a 3D model of a person during a breakdancing session (output of our algorithm)

References

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